UNIVERSITI TEKNOLOGI MARA

REMOVAL OF METALS FROM SIMULATED WASTE WATER USING PHYSICALLY AND CHEMICALLY MODIFIED CARBONIZED PALM SHELL

NUR AZREEN BINTI FUADI

Dissertation submitted in partial fulfillment
of the requirements for the degree of
Master of Science in Chemical Engineering

Faculty of Chemical Engineering

July 2013

AUTHOR'S DECLARATION

I declare that the work in this thesis was carried out in accordance with the regulations of Universiti Teknologi MARA. It is original and is the result of my own work, unless otherwise indicated or acknowledged as referenced work. This thesis has not been submitted to any other academic institution or non-academic institution for any degree or qualification.

I, hereby, acknowledge that I have been supplies with Academic Rules and Regulations for Post Graduate, Universiti Teknologi MARA, regulating the conduct of my study and research.

Name of Student	:	Nur Azreen Binti Fuadi
Student I.D. No.	:	2011699174
Programme	:	Master of Science (Chemical Engineering)
Faculty	:	Faculty of Chemical Engineering
Thesis Title	:	Removal of Metals from Simulated Waste Water using Physically and Chemically Modified Carbonized Palm Shell
Signature of Student	:	 .....
Date	:	July 2013

ABSTRACT

The rapid economic development and technological development today have led to the increase of industrial activity, which causes environmental and ecological ruins. Therefore, they raised a concern on environmental protection due to its emission and uncontrolled pollution. Industrial waste, especially metals will cause harm to the environment and ecosystem if being discharged in high concentration. Accordingly, adsorbent was widely used in metals removal for water treatment from the industrial waste. However, due to the high cost and depletion of coal-based source, the potential of palm shell as low cost adsorbent for the removal of metals element was investigated during this study. The purpose of the present study was to investigate the adsorption efficiency of modified carbonized palm kernel shell in an adsorption column for the removal of Be, Ca, Ca, Co, Cr, Cu, Fe, Li, Mg, Mn, Mo, Ni, Pb, Sb, Sr, Ti, V and Zn ions from aqueous solution. The raw palm shell underwent both the physical and multi solvent treatments. There were 6 types of adsorbent used throughout the study, which are UC1, BC1, BCAB1, BCABC1, BCABCM1 and BCABCM3. The adsorbent was characterized by the surface morphology using FESEM, elemental analyzer and the BET analysis. Surface morphology denoted the development of pores in multi solvent treatment while BET analysis was to identify the adsorbent's surface area, and lastly the elemental analyzer for identifying elemental composition of adsorbents. The results indicated that the removal of metal ions is not similar compared among adsorbents, due to the variety of treatments and the mechanism of hypothetical T-shirt pore formation. For the overall adsorption efficiency, adsorbent derived by the combination of physical, solvent treatment and multiple beds BCABCM3 demonstrated the highest adsorption capacity, with an increase of percentage removal of 92.7% compared to the UC1 (control adsorbent). The adsorbent prepared achieved high metal removal by the hypothetical T-shirt shaped pore, which exhibits high pore volume and high surface area. Moreover, the pore formed from above, below, sides of particles and narrow size in the middle of pores exhibits adsorption and reduces desorption from adsorbent surface.

ACKNOWLEDGEMENTS

In the name of Allah, the Most Gracious and the Most Merciful.

Alhamdulillah, all praises to Allah SWT for the strengths and His blessings that gave me the opportunity to complete this thesis, entitled multiple metals removal from simulated waste water using physically and chemically modified carbonized palm kernel shell. Special appreciation goes to my supervisor, Associate Prof Dr Ahmmed Saadi Ibrahem, for his supervision and continuous support. His invaluable assistances of constructive comments and suggestions throughout the experimental stage and thesis works have contributed to the success of this research. Not forgotten, my appreciation to my co-supervisor, Dr Kamariah Noor Ismail for her support, guidance and share of knowledge throughout this program.

I would also like to express my appreciation to the former Dean of the Faculty of Chemical Engineering, Prof Dr Sharifah Aisyah Syed Abd Kadir, and the Head of Postgraduate Studies, Dr Junaidah Jai for their support and assistance towards my postgraduate affairs. My acknowledgement also goes to all the technicians, especially Mrs. Azizan Din, Mrs. Rohaida Zainordin and Mrs. Nordiana Zainudin for helping me in completing my research as well as to the officers of the Faculty of Chemical Engineering for their co-operations. My sincere thanks to all my postgraduate friends, first batch of the Master of Science (Chemical Engineering) by Mixed-mode program for their ideas, suggestions, hardship, kindness, and support during my study. Thanks for the friendship and memories.

I would like to thank the Ministry of Higher Education Malaysia for awarding me with the Mymaster Financing Program throughout my Master's program.

My deepest thanks and appreciation to my beloved parents; Mr Fuadi Sumrah and Mrs Norshimah Abd Karim and also my siblings for their endless love, prayers, cooperation, encouragement, constructive feedback and full support throughout the report completion, from the beginning till the end. To those who have indirectly contributed to this research, your kindness means a lot to me. Thank you very much.

CHAPTER ONE
INTRODUCTION

1.1 RESEARCH BACKGROUND

The rapid economic development today has led to the increase of industrial activity, which causes environmental and ecological ruins. Technological development has raised concerns about the environmental protection due to its emission and uncontrolled pollution. Industrial waste produced from industrial activities such as the mills, mines, and factories will cause harm to the environment and ecosystem if being discharged in high concentration. Apart from the industrial waste, the water pollution was also caused by the municipal and agricultural runoff. The municipal water pollution consists of wastewater from homes and commercial establishment while agricultural water pollution consists of manures and slurry.

World Bank (2012) reported that, Malaysia produced 208.3 thousand kg/day of organic water pollutants with 2.8% contributed by primary metals, 16.5% by chemicals, and 6.6% by the textile industry for the year 2007. There were many pollutants contributing to wastewater pollution, including the metals, dyes and from the phenol group. The Organization for Economic Co-operation and Development (OECD), defined heavy metals as potentially toxic metals used in industrial processes, for example, arsenic, cadmium, chromium, copper, lead, mercury, nickel, and zinc, which may damage the plant and animal life at low concentrations and tend to accumulate in the food chain. The significant examples of wastewater pollutions are discharges of wastewater mixed with mercury in Minamata Bay which affects more than 10 000 people around 1950s and 1960s in Japan. Concerning Malaysia, most of the rivers were contaminated and cannot be used as drinking source. According to the Department of Environment (DOE) (2006, cited in BERNAMA, 2006), 10% of the river in Malaysia were heavily contaminated or